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ABSTRACT

A 5-year longitudinal study of factors affecting the implementation and operation of computer based education (CBE) projects in military settings using the PLATO system identified five major factors: project planning, staff selection and retention, lesson development, implementation and site management, and results and final evaluations. Findings discussed in this administrative overview of the study include: (1) it is important to clarify goals and assumptions in the planning phase of a CBE project, in addition to listing the tasks for which staff skills should be acquired, stating a plan for implementation and delivery of courseware, and providing for the final evaluation and follow-up activity; (2) staff selection and retention are often the critical features of a CBE project, outweighing hardware and software in terms of what is potentially and actually achieved; (3) several myths exist about CBE lesson development, including one which says that an author can improvise lessons; and (4) the probability of survival of CBE projects seems to be related more to their reason for establishment than to the quality and quantity of their work. An annotated list of the 24 detailed reports which form the basis for the administrative overview of the study is appended. (LLS)

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IMPLEMENTATION AND OPERATION OF COMPUTER-BASED EDUCATION

(MTC Report Number 25)

Final Report DAHC-15-73-C-0077

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The authors thank the personnel and students at the many military sites involved in this program for their continued cooperation and patience. The project owes much also to the numerous past members of the Military Training Centers (MTC) group who aided in the evolutionary development of the implementation methods employed. There are far too many members of all of these groups to mention by name, but without them little would have been possible. Finally, we are indebted to the far-sighted support of the Defense Advanced Research Projects Agency (DARPA) in funding a longitudinal study which could have few immediate payoffs. We are particularly indebted to the guidance and insight of Dr. Harold F. O'Neil, Jr., who acted as DARPA program director for most of the period of the study.

Finally, we thank the Control Data Corporation for allowing use of their inter-system PLATO link as a means of coordinating writing of this report and Elaine Avner of the Computer-based Education Research Laboratory for editorial aid in final preparation of the report.

ABSTRACT

This final report of the Military Training Centers Project at the University of Illinois provides an administrative overview of the major findings from a five-year longitudinal study of factors affecting implementation and operation of computer-based education in military settings. Most of the findings have since been found generalizable to academic and industrial training situations as well. An annotated list of the 24 detailed reports produced during the project is included as an appendix.

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INTRODUCTION

The application of Computer-Based Education (CBE) provides innumerable traps for the unwary or inexperienced. The diversity of settings, objectives, and resources in which CBE exists makes application of a few general approaches to all problems hazardous. Rather, methods which apply to specific classes of circumstances must be selected from sets of alternatives. These alternatives must be drawn from experience in the widest possible range of settings in order to avoid "solutions" that are neither transferable nor durable.

This report provides an overview of conclusions drawn from a program designed to identify such alternative approaches useful in implementing CBE in a variety of settings. The program was funded by the Department of Defense through its Defense Advanced Research Projects Agency (DARPA).

A program of implementation of one advanced form of CBE, the PLATO system, was begun by DARPA in the 1960s. In order to maximally benefit from the experience developed through implementation of this new instructional technology, DARPA also provided for a coordinated support force, which, beginning in 1972, was to oversee and facilitate a series of implementations in military instructional environments. One component of this task force was the Military Training Centers (MTC) group at the University of Illinois. After several years of implementations of CBE in a variety of military training settings, DARPA followed up with support for a summative review and evaluation of the accumulated experience. Detailed findings from this review and evaluation by the MTC group have been described in a series of special topical reports. Appendix I of this report contains an annotated list of these reports. In addition to the military experience, the findings have since been tested and augmented by experience in academic and industrial settings. This final report of the MTC project summarizes general findings in a form designed for quick review by policy makers. It is based on a presentation made by the authors at the 1979 Conference of the Association for the Development of Computer-based Instructional Systems.

More specialized reports in the MTC series should be consulted for detailed descriptions of findings. Specifically, the reader is directed to Francis (1977) for information on establishment of a CBE site, to Call-Himwich and Steinberg (1977) for information on design of instruction, and to Steinberg (1977) for a study of major factors affecting success and failure of CBE site implementations.

I

PLANNING THE PROJECT

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Control Data Education Company

As we look at what is happening in the field of CBE today, we see many new projects starting and CBE being applied in increasingly varied settings. CBE continues to be used in schools, colleges, and universities, but is seeing increasing use in military and industrial training. The persons and institutions starting new projects must either:

- Make decisions without experience (and be prepared to accept the risks that this implies)
- Hire experienced people to help make decisions (this option depends on the availability of experienced personnel and the applicability of their experience)

or

- Investigate a variety of projects to become aware of issues, alternatives to dealing with them, and the trade-offs associated with the alternatives.

As a group we have seen many new projects make uninformed decisions. We have also seen, recently, certain projects make a conscious effort to investigate alternatives prior to making full commitments. We advocate the latter approach. In this chapter I will summarize some of our experience with alternative approaches. While these approaches are generalizable, they are intended to be suggestive and illustrative rather than exhaustive.

The base of experience we drew on consisted of both direct experience as CBE designers and developers and a multi-site, multi-project evaluation of CBE. We began with direct development experience as individuals or as members of development projects. Then, under support of the Defense Advanced Research Projects Agency (DARPA) worked together as a Military Training Centers (MTC) group at the Computer-based Instruction Research Laboratory (CERL) at the

University of Illinois, Urbana-Champaign. We attempted to train members of new projects in processes of project planning, instructional design, and programming based on our own prior experience.

We then observed problems at individual sites and saw the effects of transferring some initial conceptions regarding group structures, roles, and authoring models to new settings. We also saw consequences of decisions made (or not made) by personnel in individual projects.

After two and a half years of training, liaison, and support activities, the MTC group shifted to an evaluation role. The purposes of this part of the project were: a) to document experience gained at individual sites, and b) to supplement the evaluations done by the sites themselves. Many reports were generated over a wide range of topics.

The support and impetus for this evaluation activity also came from DARPA. DARPA has made a valuable contribution to the field of CBE through its support for development of materials at each site, and through support of the MTC group for documentation of this experience.

Finally, following conclusion of the DARPA projects and disbandment of the MTC group in late 1977, the authors of this report have continued in the field of CBE and have refined their insights as they have applied them to new settings--particularly in professional continuing education and in business and industry.

This report considers five phases in the life of CBE sites--covering the span from project inception (birth) to maturity. We will report primarily about groups responsible for all phases of a project, from planning to staffing, development, implementation, and final evaluation of courseware. Our major theme is that persons responsible for new projects should be aware of the various alternatives open to them in each phase of the project. They must be aware of the consequences of alternatives and must consciously weigh the alternatives. This chapter deals with the topic of project planning.

RATIONALE

There are many reasons why a new project ought to do some good planning and virtually no reasons for choosing to skip the planning phase. Planning should be non-controversial. Everyone is in favor of adequate planning. Nevertheless, planning is not always done well or completely. Either what is involved in planning is not understood (i.e., the required products of the planning phase are not apparent), or planners are not aware of all the alternatives, trade-offs, and pitfalls that must be considered. I shall outline some of the most basic issues which must be dealt with in the planning phase.

Project planning is an extremely broad topic in that it is an activity that should continue throughout the life of the project. The topic of planning overlaps with the other chapters in this report.

Since there are literally hundreds of issues that should be addressed in planning and managing a project, I cannot be exhaustive. However, I hope to illustrate the process.

In considering how to approach the topic I have had to choose between either describing the planning done in various sites studies and the pitfalls encountered in each or suggesting a general approach to be taken by planners of new projects. I have decided to do the latter.

The planning phase should address the major management issues to be considered in each of the remaining phases. Problems or decisions that are not anticipated can be the total undoing of a project.

The products of the planning phase should include the following documents:

- A statement of project goals together with lists of assumptions and constraints that have shaped the goals.
- A plan for staffing and assigning staff to tasks.
- A plan for arranging facilities and hardware.
- A plan for implementing the courseware in the instructional environment--i.e., a plan for assuring usage.
- A plan for final evaluation and follow-on activities.

These plans should represent a thorough analysis of the issues relevant to each phase. They should show evidence of consideration given to alternatives. The plans should be flexible; they should be based on what is known or assumed, but they should be capable of being modified in light of changing circumstances.

DOCUMENT GOALS AND CONSTRAINTS

The first step in the planning phase should be the process of goal clarification. There are many potential reasons for becoming involved with CBE. These include: a) improvement of on-the-job performance; reducing costs through reducing errors, b) reduction of costs of training by shortening training time or eliminating expensive equipment, c) improvement of motivation, thus reducing attrition, d) standardization of training, e) presentation of tests, prescription of learning activities, and record keeping--functions handled by computer-managed instruction, f) research on such topics as human learning, implementation of technology, methods of multi-person/multi-site research and development, g) enrichment of the curriculum by preserving expensively taught courses and teaching topics that could not otherwise be taught, and h) remediation in basic skills to free the teacher to deal with individual learning needs.

Although each of these aims may be attainable in different settings by proper application of CBE, they are not all mutually compatible within a single project. There is potential for conflict between research aims and operational training, as demonstrated by the first phase of the Chanute project. There may be, for example, potential conflict between the goals of a narrowly defined pilot project and the goal of high visibility and continued use across many departments.

During goal clarification, planners must determine those goals which grow out of real needs and which have the most support in the organization. After clarifying the goals for the project, the project planners should document them together with constraints and assumptions. Finally, the planners should be prepared to continue the process of goal clarification throughout the life of the project. There may be a new dean or new superintendent or new general in a decision-making role who does not understand or does not agree with the established goals, or original assumptions might prove invalid and the relative priorities may change. Once the project's goals have been clarified, the planner can move on to the problem of planning the staff required.

PLAN FOR STAFFING

The first step is to determine tasks that must be carried out by the project staff. A major issue is whether the staff will do development. The alternatives are: assemble a staff to develop your own courseware, use the courseware developed by others, or contract an external vendor to do custom development. Planners must consider the consequences of each alternative. The planners must consider those tasks to be done by the project staff and those that can be done by others in the institution. The planners must also identify all the tasks; it is extremely easy to let some slip through the cracks. Next the planners must identify the skills required among staff members to cover those tasks. Finally, the planners must obtain a staff with the necessary skills either by training individuals in the desired skills or by hiring experienced personnel.

PLAN FOR THE MANAGEMENT OF THE DEVELOPMENT PROCESS

During the planning phase the project manager should establish a plan for management of the development process. A first step is to plan for the integration of CBE activities into a total course. A total course design is based on the training problem whose solution is sought, accounts for various constraints, and provides an overall structure in which individual activities fit. Planners cannot expect to develop individual lessons and have them used unless they are designed to fit in a context. It is also necessary to:

- Establish milestones with which to gauge progress during development.
- Plan to collect data on time being spent on various activities and compare these with the plan and the milestones. Either adjust the procedures used during development, adjust the staff assigned, or adjust the milestones and ultimate goals.
- Plan the role that formative evaluation will take, including reviews by peers, subject matter experts, student testing, and revision cycles.

IMPLEMENTATION

The next major document of the planning phase should be a plan for implementation and delivery of courseware. Organizational acceptance and commitment does not just happen--you must plan for it. The roles of instructors and administrators vis à vis the new courseware should be worked out. Planners must be certain to cover a real need that can build acceptability into the product. Resources should be based on need-- too little or too much should be avoided.

FINAL EVALUATION AND FOLLOW-ON ACTIVITIES

A final planning document should provide for final evaluation and follow-on activities. The evaluation plan should be oriented toward decision-making. The plan should identify audiences for evaluation as those persons who will be making decisions about the courseware and the development project. The plan should identify the information needed to make decisions while planning for as much redundancy of measures as can be afforded.

Because decisions are often made before the final report is available, the evaluation data collection and reporting should be continuous throughout the project. Decisions made prior to project completion will affect staffing and schedules during the last phases of the project. The plan must also provide for maintenance and revision of the courseware.

As a given project comes to a close, the plan for that project ought to take follow-on activity into account. The optimum organization, staffing, and facilities for one project may be totally inappropriate for subsequent work. In addition, unless the prospect for follow-on activities is clear and appealing, staff members may leave early, thus jeopardizing completion of the original project. If no follow-on activities are expected, the project planner must provide for an orderly shut down or a maintenance effort.

These have been some of the requirements for outcomes of the planning phase. Once these plans have been assembled they should be reviewed by project planners and sponsors in the light of experience of other projects. Gaps and potential pitfalls should be identified and provided for.

CONTINGENCY PLANNING

Planners must build flexibility into their plans. It is a fact of life that circumstances change, assumptions are invalidated, and new constraints arise. Murphy's Law-- Whatever can go wrong will go wrong-- applies just as well to CBE development efforts as to other enterprises. The CBE manager's only defense against these changes is to anticipate them and to have a second, back-up plan in the wings: a contingency plan.

The task of the manager in contingency planning is simply to go through the entire set of planning documents and ask the question "What if..." For example, "What if there is a change in upper level management. Will these goals still be acceptable?" "What if I am not able to hire and train all the people I need?" "What if my prime subject matter expert is killed in an accident?" "What if the production rate is slower than planned?" "What if the student sample is thinned due to attrition? Will there still be enough data to answer the evaluation questions?"

Acceptable alternatives to these contingencies should be adopted as part of the overall plan. If there is not enough flexibility in the constraints on the project to allow for one or more of these disasters, the manager is riding a time bomb that will eventually explode.

SUMMARY

This chapter has presented a very general overview of some of the principles of project planning.

The products of the planning phase should include documents which clarify the project's goals and stated assumptions, list the tasks for which staff skills should be acquired, state a plan for implementation and delivery of the courseware, and provide for the final evaluation and follow-on activity.

Once the plans are established, they should be reviewed in light of experience with pitfalls in other projects. The entire set of plans should be backed up with contingency plans that are acceptable to the sponsors.

While these guidelines may seem totally obvious and self-evident, they are not always followed. Detailed analyses of the planning done for individual projects reveal examples of both good and bad planning. We hope that all future projects will be examples of good planning.

II

STAFF SELECTION AND RETENTION

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When computer-based education (CBE) centers or projects are described, often the first characteristics listed are the computer hardware, terminals, and software. Next, perhaps, the subject matter areas are used to categorize the activity at a center. Information about the composition of the staff is typically given less attention; nevertheless, investigations have shown that staff characteristics and staff structure have often been the critical features of a CBE center, outweighing hardware and software in terms of what was potentially and actually achieved.

ROLES VS. SKILLS

In most fields, when considering what staff to hire, an administrator examines the program objectives and begins writing job descriptions for the roles of the staff needed to accomplish the objectives. In the field of computer-based education, this approach is not always the most practical. Because of the limited availability of people with CBE-related experience, we suggest that staff members be selected and described on the basis of skills, rather than by roles (Francis, 1977). Thus, instead of referring to authors, one refers to staff members with programming skills, subject-matter expertise, and/or instructional design skills. Because job candidates are likely to possess a crazy-quilt pattern of skills, premature combining of skills into roles and job descriptions imposes unnecessary constraints on the staff selection task. Skills we have found necessary in most CBE development programs include (Steinberg, 1977):

- Administration/Management
- Leadership
- Curriculum coordination
- Subject-matter expertise
- Instructor experience
- Instructional design

- Evaluation/Testing
- Programming/CBE expertise
- Editorial skills
- Artistic/Illustrative
- Proctoring skills
- Secretarial/Clerical
- Experience with other media

There are several additional advantages for choosing staff by skills rather than by roles. One of the most consistent findings of a study of PLATO courseware development procedures in military and civilian environments was that new courseware development groups changed their organizational structure one or more times during the three-year period examined (Mahler, Misselt, Schell, & Alderman, 1976). The upset caused by reorganization can be somewhat minimized by emphasizing skills (which change slowly), rather than roles (which are changed suddenly by the reorganization). For example, consider a staff member who would traditionally be classified as an author. If he had difficulty mastering the CBE language, the administrator might assign him only subject matter tasks and responsibilities. Thus the staff member would not waste time or feel frustrated by trying to become a well-rounded author, but would use the skill(s) in which he is strong.

Another advantage for using a "skill" orientation is that such an approach may convince an overworked CBE director who has managerial, leadership, and curriculum coordination functions that he can continue in a leadership capacity, but delegate other functions to subordinates.

TEAM AUTHORING

It has been assumed in the previous discussion that some sort of "team" is being used to develop CBE courseware. Although any multi-person effort might be said to employ a team approach, it is useful to distinguish at least 3 levels of teams.

- Independent authors may divide the content, but do all parts of courseware development themselves.

- One staff member may make the decisions about design, content, and programming, but "sub-contract" support staff to do portions of these tasks.
- No single person may make all the decisions about design, content, and programming. In this situation responsibility for a piece of courseware is shared among the developers. Development is like an assembly line and control passes on when a stage of development is complete.

Advocates of this last form of team authoring often feel that they have found "truth" and "THE method" in comparison to authoring courseware more independently. In fact, the objectives, time constraints, and author backgrounds strongly affect what solution is best for a given situation.

Many courseware development groups start out in the "team" mode described first and gravitate toward approaches with a higher degree of specialization. Often such a pattern is predictable. A loose, independent organization is simple to set up and operate. However, because few staff members possess all the skills needed to be effective authors, uneven, inconsistent courseware begins to emerge. Similarly, staff members' individual strengths and weaknesses are found. In order to enhance productivity and increase uniformity, the manager of courseware development groups then decides to assume the larger administrative burden associated with the second and third forms of the team approach. Thus, the staff's strengths are exploited and the manager achieves greater control.

SELECTION OF THE DIRECTOR

It is obvious that the selection of a group leader or project director has a major impact on the success of any endeavor. Because qualified managers are difficult to find, the management staff is often over-extended in an attempt to get maximum use from those managers who are available. In some cases a manager will try to oversee five or six different programs or projects. Our experience shows that whenever the staff members to be supervised exceeds three full-time equivalents or five people, a full-time administrator is generally needed. We have found two other criteria to be useful in determining the appropriate "load" for an administrator:

- The manager should have enough time available to see students using CBE. Unless this time is made available, the manager tends to evaluate the CBE lessons and project only from his perspective rather than as the students/trainees see them.

- The manager should be the appropriate "distance" from the CBE activity: neither too close nor too far. Some managers who have acted as both a CBE developer and also as the manager found it difficult to focus on the long-term administrative issues because the short-term development issues got in their way. At the other extreme, one supervisor found that because of his unfamiliarity with the details of his CBE project, he was left out of the decision-making process. His subordinates found that he could not quickly grasp the issues and hence made the decisions themselves.

SELECTING CBE DEVELOPERS

The CBE developers one can hire typically have one of three backgrounds: subject matter expertise, instructor experience, or a programming background. Each type of person may become a full-fledged CBE author, but each has a potential weakness or difficulty of which to be aware. Subject matter experts may produce lessons which tell, but do not teach. The lessons may be technically sound but lacking interaction, questions, and pedagogy. As a result, the materials are boring. Instructors who become authors have a better chance of understanding what educational strategies will work with students; unfortunately, robbing the classrooms to develop CBE may be "expensive" in that classroom students must suffer from inexperienced instructors. Former programmers tend to view CBE lessons without a sense of esthetics. If a lesson executes properly, they may be completely satisfied. Students using such a lesson may find displays awkward, introductions missing, and learning difficult. All of these types of people have been successfully trained as CBE developers; the purpose here is to suggest potential areas of weakness which demand the manager's attention or supplementary training.

FRACTIONAL APPOINTMENTS

The subject of fractional appointments can be condensed to one sentence, "In CBE projects to date, there have been too many full-time authors and too few full-time directors". Directors have already been discussed; part-time authors will be treated here. When "drafting" CBE developers from the classrooms for a CBE endeavor, it is often effective to let them retain a fractional commitment to their former position. Such a staff member can perform useful liaison activities: reassuring current instructors, finding student "guinea pigs", squelching rumors, and basically maintaining rapport between the CBE developers and the classroom staff.

One major problem with split appointments is that actual CBE development time tends to be less than that officially scheduled. Because test writing, meetings, grading, and other activities have firmer deadlines and are more structured activities than CBE tasks, the CBE work suffers. Separate offices and definite time slots for each kind of activity are an aid. When a large curriculum is being rapidly developed, the need for coordination among developers is so large that staff members working less than half time generally find too little time left over for efficient work. However, small fractions may be fine for staff members not involved in coordination meetings (e.g., subject matter experts or programmers). Part-time student programmers have often been employed with high cost-effectiveness.

STAFF MORALE AND MOTIVATION

Once a staff has been selected and trained, the administrator's next worry is attrition. Loss of trained staff members from a CBE group can be expensive, not only in terms of replacement cost, but also in terms of lost time and unplanned, but necessary, staff reorganizations. Because financial rewards for a superior performance can generally be given only once a year and are subject to many other constraints, smaller non-financial rewards can be used to thank, motivate, and reinforce a deserving staff member. Morale of staff members is enhanced when the following actions are taken:

- Recognition of the contribution of a staff member on the credits page of a CBE lesson or in reports, journal articles, proposals, etc.

- Use of a staff member's CBE lessons during a demonstration. An even greater compliment is to have the staff member give all or a part of a demonstration.

- Releasing resources such as disk space, computer time, and computer access privileges for "side" projects or personal use by staff members or their families.

- Allowing individuals flexibility in their working schedules. In fact, because flexibility is potentially possible in most CBE environments and is obvious to all, failure to offer it may cause discontent.

- Giving an "ego boost" by scheduling student use of a well-tested lesson written by an author. Students and instructors generally make at least a few complimentary statements, and the dwindling number of corrections needed serve to remind the author of just how polished the lesson is becoming.

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III

LESSON DEVELOPMENT

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An author at a remote PLATO site had just returned home after a one-week course in coding which included a smattering of instructional design. The course was his first exposure not only to coding and instructional design, but to computers of any sort as well. He felt challenged by and enthusiastic about the potential of CBE. He was eager to begin writing his own lessons. He thought writing lessons was tremendously creative and he regarded himself as a creative person.

During the short training course, the instructor had stressed the importance of preplanning as the first step in lesson writing, with particular emphasis given to the careful construction of a list of the tasks the author wanted the student to be able to perform by the lesson's end. During the training course, the author had seen the importance of such prior analysis, but once he got home and began writing his first lesson, he found prior planning rather tedious -- a little like having to practice scales when what you'd really like to be able to play is Beethoven's "Pathetique." He tried to decide what material should be included, and how it should be organized, but he felt stifled, anxious to really "get down to writing the lesson." He finally announced that he was "too creative" to function this way. His "technique" would be to sit at the terminal and compose, impromptu style, adlibbing as he went along. This procedure felt much more comfortable. He found himself bursting with ideas. He had seen some fascinating games, and wanted to write a game; he had seen some dazzling displays, and wanted to create some graphics. He struggled, but felt invigorated by the struggle. He labored, but felt challenged by the labor. He rhapsodized, "Writing lessons is so creative and personal -- it's like giving birth!"

Slightly over a year later, he bore a rambling, hopscotching, patchwork of a lesson. Throughout the year, most of his time had been eaten away by reworking, reshuffling and re-writing what he'd already done. New material was tacked on to the end of the lesson in a rather "Oh-and-I-forgot-to-mention..." manner. He'd constructed a game, but the rules were so complicated, students got too befuddled to play. He had included some graphics, but they were juvenile and cartoonish. Students came to refer to the lesson as "Sesame Street."

That's a useful anecdote (which, by the way, is true) because it encompasses not only a number of common design problems, but a number of managerial problems as well. Before discussing specific design issues, let's look at the ways in which misguided management decisions (and lack of decisions) helped undermine this situation.

This project was staffed by a number of subject-matter specialists representing a wide range of programming and teaching experience. No one was familiar with with the TUTOR language or PLATO capabilities. However, author training time was included in production time. Time and budget being primary issues, authors were sent first to a very short course, and then expected to begin producing curriculum materials immediately. In this way, each author was essentially behind from the very beginning. In addition, the time press helped foster the feeling among administrators and authors alike that the only really productive work -- or as our author put it "getting down to writing the lesson" -- was actual lesson programming. The result was a lack of any standardized development procedure. Each author was left to develop materials in whatever way he saw fit.

Without dampening any "creative" inclination, an alternative approach would have been to adopt a set of project standards to which lessons should conform. Another technique which has proved useful at a number of sites is the development of a driver which could be used as a mainframe for project lessons. Such drivers not only standardize some educational practices (such as use of student objectives and lesson "roadmaps"), but also provide individual authors with a pattern for organizing material and routing students through their lessons. Far from hampering creativity, standardized drivers can free authors' time to deal with lesson material at a more innovative level.

Finally, since no one on staff had any knowledge or experience with TUTOR or CBE, even novice authors were left with very little programming or design support. Consequently, some lessons remained limited to heavily texted displays and student interaction that was easiest both to compose and code.

As for the author in the anecdote, he fell prey to a number of pitfalls that could fairly easily have been averted. His biggest problem was in not knowing how to think about developing his lesson. Basically, his thinking centered on the content rather than the student. This orientation is partially responsible for his continuing to tack added material onto the end of the lesson. An alternative (and ultimately time-saving approach) would have been to first enumerate the tasks he expected the student to be able to perform and then divide those tasks into their component sub-tasks. Tedious, perhaps, but in doing so the author provides him/herself with not only an interlocking hierarchical framework for the lesson material, but also a point of reference by which to weigh the relevance of both content information and possible presentation techniques.

Another pitfall was visible in this author's use of various graphics and games for their own sake rather than for their educational value or relevance. Without a clear definition of the student goals, the author developed a somewhat short-sighted perspective toward presentation. Graphics and games became an end in themselves.

COMMON DEVELOPMENT MYTHS

Perhaps this author's greatest oversight was in believing a number of "myths" of lesson development. First, and doubtless most disastrous, was the myth that:

An author can improvise a lesson. Our author was well-intentioned, but misguided (and reinforced by administrative attitude) in believing that planning and writing a lesson are somehow separate. That's like saying playing the flute and learning what finger positions produce what notes are two different things.

No one, not even experienced authors, can simply extemporize. While it's true that authors often "compose" at the terminal, they are able to only because they have a firm basis of experience. This author was misled by the outward behavior of more experienced authors. He didn't see the mental organization that had gone on or the fact that they were able to "adlib" only because, having written a number of lessons, they had practiced and become proficient at the necessary skills. Which brings us to his second misconception:

If you know how to teach, you know CBE. Any craft is grounded in a certain set of skills/tools with which the craftsperson must be proficient. They are the heart of the craft. Just as one would not assume a pianist could automatically play the flugel horn, one should not assume an instructor automatically knows CBE. They're in the same field, but require different skills, approaches, etc. They have different potentials and capabilities and only some similarities.

Presenting is teaching. The author also believed that simply by stringing some bits of information together, he was teaching. A more extreme example is the medical CBE site at which the emphasis on content alone resulted in lessons evolving into "page-turners" -- heavily textual, bookish lessons with little student interaction. Students were strongly encouraged to sit at their terminals and take notes. Most did -- like modern day scribes, conscientiously transcribing books of their own. Expensive books, to say the least.

Lesson development is a one-shot effort. In the long run, one of the most harmful beliefs an administrator or author can harbor is that lessons are written in a single sweep.

At one fledgling site, the staff (entirely composed of novice authors) disregarded consultants' warnings that lesson development is an iterative process that should be interspersed with numerous trial test runs. The authors chose instead to believe that by having a couple of colleagues go through their lessons, they could eliminate virtually all programming or design errors.

Within days of unleashing their lessons on students, authors found themselves frantically fixing errors as fast as they were reported so that students could either get out of or get into various portions of lessons. Students were stymied by questions which gave them no clues or help, and no way to move backward or forward. Within months there was a virtually unanimous student mutiny, with nearly all students asking to be reassigned to a non-CBE class.

This example speaks for itself. The time investment in trial test runs can save time in the long run. Authors at this site felt panicked by the fact that these "fix ups" were cutting into what they were made to believe was production time. Debugging was not regarded as "producing." A better approach would have been to schedule trial runs into the project time-lines from the very beginning.

Basically, lesson development is a question of managerial and author perspective. From the outset, emphasis should be placed on student-orientation. Production should be seen as a multi-layered, iterative process of planning, programming, and testing. Inexperienced authors should be bolstered by coding/design consultants. The model of the crash-course trained, self-sufficient author is as unrealistic as the concept of a one-man expedition to the North Pole.

IV

IMPLEMENTATION AND SITE MANAGEMENT

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In 1972, the Defense Advanced Research Projects Agency (DARPA) began a large scale investigation of the educational and cost effectiveness of the PLATO CBE system. This experiment spanned a period of almost five years and, when fully implemented, placed more than 100 PLATO terminals at the disposal of military users throughout the country. About half of these terminals were used either singly or in small groups to explore limited research questions. The remainder were divided among three military training sites for direct investigation of CBE educational and cost effectiveness. These sites shared most of the management and implementation problems of the smaller military sites along with special difficulties that accompany the development of substantial packages of CBE courseware. In the smaller sites, for example, the limited research objectives often dictated what instructional strategies, if any, should be employed, whereas the curriculum-development sites needed individuals who were capable of resolving complex instructional design problems within a project's complex environment. Furthermore, with staffs of 14 to 20 individuals at these sites, managers faced the problem of meshing a variety of talents into an effective courseware-development team, while the smaller sites often involved only two or three individuals. With their larger goals and staff, problems of management and implementation and possible solutions were somewhat more apparent in the larger DARPA/PLATO sites than in the smaller ones. It will, therefore, be more informative to focus attention on the richer experiences of the curriculum-development sites.

The authors at these sites were trained by staff members of the Computer-based Education Resarch Laboratory (CERL) at the University of Illinois. At CERL, the most striking successes in using the PLATO system had been obtained by individual authors who had possessed whatever subject matter, programming, and instructional design expertise they needed to develop their lessons. Coming from this environment, this authoring model was naturally emphasized. Moveover, in the early 1970s many workers at CERL believed that it was easy to become a competent PLATO programmer. The managers of the large DARPA/PLATO sites initially shared this belief. Consequently, they dispatched subject matter experts to CERL for training in the happy expectation that in a few weeks time the wedding of their subject matter expertise and newly acquired PLATO programming competence would produce a vigorous, new generation of lesson materials for their training programs.

At none of the DARPA/PLATO sites were these expectations realized. At two of the sites, extensive reorganizations giving the authors more narrowly defined roles were needed to reverse a trend of slow and inefficient lesson development. At the third site, slow development of lessons of very uneven instructional quality compounded with management problems led to the abandonment of the initial project objectives.

The unfortunate experience of these sites with this particular model of the CBE author reinforces the dictates of common sense. After all, a self-sufficient author must be highly skilled in several different areas. It is unlikely, therefore, that the project managers would find in their staffs an aggregation of individuals who uniformly possess the multifaceted talents needed to be competent self-sufficient authors. In fact, given the diversity in subject matter knowledge, programming ability, and instructional design experience that existed on these projects, one would have least expected the self-sufficient author model to be adopted. To be sure, part of the blame must be given to the initial training that the DARPA/PLATO authors were given at CERL. Nevertheless, the inappropriate use of this model is currently prevalent in projects that did not have the same initial exposure to the PLATO system. It thus appears that some other factor may have also influenced the adoption of this model.

The model of the self-sufficient author is the easiest model for managers to adopt for a CBE project staff. Since a manager need only assign entire CBE lessons to authors, he can ignore the complicated problems of coordinating the talents of his staff. Thus, this model is often adopted in the absence of any thoughtful plan for full utilization of project resources. As such, it is a default authoring model and is characteristic of projects which lack experienced leadership.

Those DARPA/PLATO project managers who had experience in administration and instructional development did not give their authors a free and independent hand in developing their lessons. At best, they adapted development procedures to fit the capabilities of their staffs. While they may have favored a particular model of development, the realities of staff selection generally made the use of the favored model impractical. Thus, they were faced with assessing their team's talent at the project outset and adapting lesson development procedures accordingly.

At two of the DARPA/PLATO sites, after an unsuccessful trial with the self-sufficient author model, the project managers revamped their lesson development procedures to conform better to the talents of their staffs.

At one of these two sites, there was little expertise in instructional design among the authors. The project manager who had spent a substantial portion of his career as a curriculum designer developed a lesson strategy to be used by all project authors. Thus, the authors were freed from design considerations which they were poorly prepared to cope with. Since the authors were mostly weak programmers, the manager designated the group's strongest programmer as the "Senior Author" and encouraged the other staff members to refer their programming problems to the Senior Author. This procedure not only freed the authors from another task they were ill-suited to do but it made the solutions to programming problems readily available to the entire authoring staff (Himwich, 1977b).

At the other site, the authors were not subject matter experts but were fairly competent PLATO programmers. In this case, the project manager, who had long experience with developing instructional materials for military training, brought in several experienced instructors to oversee the content and presentation of the lesson materials. In this project, the PLATO programmers were freed from the problems of becoming subject matter experts and instructional designers to concentrate on effective use of the CBE medium. The manager of this project made the team's strongest programmer the programming consultant for the rest of the project staff. As with the former project, a direct benefit was realized (Himwich, 1977a, pp. 45-53). The overall effect of this reorganization was especially impressive. Whereas 650 hours of authoring time were needed for one student contact hour before the reorganization (Himwich, 1977a, p. 40), only 100 hours were needed for the same amount of CBE instruction under the revision lesson development scheme (Himwich, 1977a, p. 49).

At the remaining ARPA/PLATO curriculum development site, the project manager had very little experience as an instructional designer. The only member at the time who had any training in this field was not allowed to have a significant impact on lesson development plans (Misselt, 1977, pp. 24-25). The project manager intended to treat his staff "as professionals" and thus passed on to them the problems of how to develop their lessons. This approach substantially contributed to the fragmented project output with slow development times, some highly eccentric and ineffective PLATO lessons, and a disgruntled staff.

While the decision of how to deploy a staff in developing CBE courseware must take into account the various capabilities of the staff members, it must also allow for the constraints of project completion time. The tighter these constraints, the more efficient must be the production methods. Such efficiency is usually obtained by producing prosaic courseware which takes little advantage of the CBE potential for individualized instruction. If time constraints are not great, it is possible to depart from an assembly line approach and assign tasks within the project with an eye to producing CBE materials of high quality.

Whatever the time constraints of a project, they must be considered carefully, along with the amount of courseware to be produced at the outset. The result of such an assessment should be a time-table for the completion of various project phases. In addition to the quantity of courseware to be produced, an estimate of the number of authoring hours needed to produce a unit of courseware must enter into the determination of the project timetable. Although these timetables and estimates of production rates must be tentative, they at least give a way of measuring progress during the project. Most of the managers of the DARPA/PLATO sites created such timetables and derived estimates of production rates. Some of them erred, however, in not using these estimates to modify their lesson development procedures when early progress was slower than anticipated. For most projects, the completion date is not a variable factor. Thus, when production times are slower than planned, development procedures must be modified since deadline extensions may not be possible.

Two examples from the ARPA/PLATO project illustrate the importance of project timetables. At one of the sites, lesson development was based on the model of the self-sufficient author. The project manager knew that a production rate of 300 authoring hours for each student contact hour was necessary to meet his objectives. When the first lessons took longer than this to produce and when they were judged to be of poor quality by reviewers external to the site, he reorganized his staff to steamline production and improve lesson quality. In this case, the initial timetable helped to provide a stimulus for reorganizing the staff (Himwich, 1977b). In the other case, an even more complete timetable was drawn up also with an estimate that 300 authoring hours per student contact hour would be needed to meet the timetable. This estimate had failed to account for non-authoring duties as well as several other time-consuming, but forseeable, problems that the project suffered in its early stages (Misselt, 1977, pp.22-25). The initial authoring model employed at this site, actually adopted by default, was that of the self-sufficient author. As time pressures mounted for this project, the manager made no attempt to modify lesson development procedures although such modification was clearly indicated.

These two cases not only point up the importance of using one's timetable once it has been derived, but also the damage that authors attempting to be self-sufficient can do to such timetables. Part of this damage originates from the fact that most authors are not skilled enough to be self-sufficient so that they tend to work very slowly as they acquire needed skills. However, the main problem arises from the fact that authors working in this manner tend to view a CBE lesson as an infinitely perfectable work. Being naturally sensitive to the shortcomings of their work, they continue to polish them unless their access to the lessons is actually restricted.

While the most excessive and wasteful expenditures of time and labor occur when a lesson has a single author and when that author has complete automony in determining when his work is complete, a similar sort of problem can arise independent of the lesson-production procedures being used. Although this problem may take on different appearances, it always arises from the fact that any CBE lesson can be improved. Thus, a lesson-production unit, whether it is a team or a single individual, can always find ways to work on satisfactory lessons. For this reason, it is essential that project managers devise criteria for determining lesson completion and apply them vigorously.

In summary, experience with the ARPA/PLATO project suggests that the following management precepts are vital to the success of any CBE project:

1. The model of the author as a self-sufficient combination of programming, instructional design, and subject matter expertise is not realistic in most CBE production environments.
2. A division of labor in lesson development should therefore be established to take advantage of available resources.
3. A list of project milestones and a timetable for their attainment should be drawn up early in the project so that estimates of progress can be made and appropriate remedial actions taken when needed.
4. The determination of when a portion of CBE courseware is completed should not reside in the hands of the people directly involved with the courseware.

The apparent a priori validity of these ideas would lead one to believe that they are nothing more than common sense applied to CBE development. During the DARPA/PLATO project, however, they were frequently ignored. For this reason and the fact that a survey of current CBE projects shows only haphazard application of these ideas, it can only benefit us to be reminded of them.

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V

RESULTS AND FINAL EVALUATIONS

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The mature computer-based education (CBE) production effort constitutes an end point of both a product and a process. By evolution or by simple trial-and-error, mature production groups are most likely to have developed both exemplary applications of the medium and exemplary procedures for efficient production of such applications. Even where these goals are not met, the fact that a group has gone through the full production cycle one or more times means that there are probably valuable lessons to be learned from an examination of its history.

The findings reported here are based on longitudinal studies of 22 instructional design groups, cross-sectional studies of six additional groups, and observations made during more than 100 evaluations of major CBE design projects. Consistent findings from these studies over the past 18 years suggest that it is now possible to make several general statements about the relationships among group productivity, group structure, experience, quality of work, and work environment.

PROCESS CHARACTERISTICS

Mature CBE production groups show patterns of both capabilities and working methods which are distinct from those of beginning groups. In some cases the differences are only cosmetic, involving little more than facility with the jargon and the mythology of the medium. In other cases the differences are more substantial and reveal themselves in highly efficient production of effective instructional material. The most consistent difference seen between beginning and mature groups is, as would be expected, a higher rate of productivity. However this difference is only partially the result of higher levels of experience among individuals within mature groups. Even in groups with relatively high rates of personnel turnover, the established organization can show efficiencies as a result of knowing what is essential and what is not essential in the training of new workers. Established groups also show heavy use of standardized repertoires of procedures which eliminate time-consuming exploratory efforts.

Differences between mature groups with equivalent amounts of exposure to CBE seem related to three major factors: (1) the extent and pattern of production demands placed on the group, (2) the variety of instructional settings in which a group produced materials, and (3) the degree of commitment toward producing measurable changes in student performance.

Production demand. Studies of individual author productivity (Avner, 1979) show that one of the major factors determining production rate is the extent to which authors experience a continued pressure of short-term deadlines for production of material. Authors who have met months or years of two- to three-week deadlines for producing completed CBE instructional modules show production rates that are a several times higher than those of individuals who have never met continual short-term deadlines. Production rates of 30 author hours per hour of student material are not uncommon even in instances where pedagogical structure as well as content must be produced.

Variety of experience. The quality of material produced when a group is faced with changes in student population or changes in types of instruction required seems highly related to the range of past experience of a group. Groups which have extensive experience in providing instruction of a single type to a restricted population of students tend to overgeneralize procedures which were found to be effective in that situation. This tendency toward overgeneralization is particularly virulent when the past experience was very successful.

Performance orientation. Development of effective instructional approaches by a group seems ultimately to depend on a commitment of the group or its leadership to production of material of demonstrable effectiveness. No group is ever likely to admit a desire to produce poor quality material, but many groups demonstrate a head-in-the-sand approach to production which almost assures such an outcome. Groups where frequent, early testing with students is used to gather data which are immediately used in a revision process show a high likelihood of producing both high quality material and a repertoire of general procedures that will assure efficient future production of similar materials. Groups which concentrate only on measures of quantity of output show a high likelihood of producing both low quality material and a repertoire of procedures for efficient production of similar low-quality materials.

Unfortunately, quantity is easier to measure than quality, and far too many groups gradually yield to use of module or lesson counts as the sole index of group effectiveness.

Administrative considerations also differ in type and importance for new and mature CBE projects. The mature production effort is faced with a class of problems that the beginning group sees in only a limited fashion. Foremost among these problems are those of maintenance, documentation , and updating of existing materials. Some successfully implemented materials have died an agonized death because of insufficient planning for long-range support. With turnover of personnel, inadequate documentation frequently proves the undoing of projects which have to devote more time to upkeep of packages than was invested in the original production.

Confusion between start-up and steady-state costs and the fact that these costs continually change in relative importance during development of a project causes administrative headaches to projects at all stages of life. New groups may either ignore start-up costs or mistake them for steady-state costs. Mature groups are well aware of the burden of steady-state maintenance costs but may erroneously assume that they have left major start-up costs behind them forever.

PRODUCT CHARACTERISTICS

In a field such as CBE where major learning is still going on among experienced practitioners, groups which communicate effective techniques to other groups can be considered to have produced a product that is at least as valuable as the instructional materials designed for more typical students. In fact, several of the groups studied had research rather than production goals and intended to produce reports which would communicate effective techniques for use of CBE.

Formal reports of instructional development efforts by mature groups were rarely in a form which would convince others of the efficacy of the medium and only slightly more frequently in a form which showed convincing evidence of the effectiveness of the design effort itself. This paucity of evaluative output was particularly evident in academic settings and in projects operating on a job-shop basis. Single-task oriented groups (especially those with research goals) showed a higher incidence of evaluative efforts in final product descriptions; however even these were often limited to provision of evidence that efforts had been expended and products generated.

Attempts to communicate CBE instructional design skills to others by journal articles or technical reports often seemed inversely related to the actual record of productivity of a group. This relationship seems most likely the result of the fact that such reports are often motivated by professional or contractual demands which are rarely present in job-shop production (the setting where the greatest depth and range of experience is likely to exist). In several instances it was found that groups said less and less publicly about methods of CBE design as their experience grew. As a result, the several excellent publications and planning guides available for those seeking initial aid in structuring design efforts are not supported by an equivalent literature giving support for the practical problems of efficient production of effective material.

Both the disappointing lack of formal evidence for effectiveness of materials and the lack of public descriptions of effective CBE applications and techniques are probably a predictable outcome of the implicit goals of most of the projects observed. Production efforts rarely had to validate their materials in a form designed to convince persons other than local consumers. Research efforts often focused on methods designed to work with a wide variety of media, with the result that techniques unique to CBE were sometimes actually avoided. Despite these disappointing trends, effective materials and techniques were developed and were documented in some cases (Avner, 1978).

OUTCOMES

The probability of survival of the mature projects observed seemed to be related more to their reason for establishment than to the quality and quantity of their work. Projects organized for single tasks (e.g. to carry out a contract or produce a course in a given area) showed the highest probability of being dissolved after completion of the task. Given the stated goals of such a project, this outcome is certainly to be expected. Nevertheless, in most cases it turned out to be an outcome unintended by members of the projects. With only rare exceptions, organized groups attempted to extend their existence beyond the completion of the intitial goal by seeking funding for additional projects. Based on the evidence for improved productivity by these mature groups, such efforts are certainly in the best interests of the educational community. Unfortunately, where added funding was not immediately forthcoming, experienced members of such groups were usually quickly lured away by other production groups, and the original group was left with insufficient resources to support further production efforts even if the funding became available.

In conclusion, mature CBE design groups that have produced a wide variety of materials under continuous moderate deadline pressure possess skills in quality and quantity that go well beyond those possessed by beginning groups. These skills have the potential for allowing production of instructional products of superior effectiveness. However, information about the nature of these skills or the effectiveness of resulting products is seldom being communicated well by members of experienced groups. Finally, continued survival of groups is rarely related to their production record.

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APPENDIX I

ANNOTATED LIST OF MTC REPORTS

These reports contain the detailed information that forms the basis for this final report as well as providing an historical commentary on the evolutionary growth of experience of the application of CBE in military settings.

Except where noted, reports in this series are available at cost from the Documentation Office of the Computer-Based Education Research Laboratory, University of Illinois, Urbana IL 61801. ERIC accession numbers are also given for reports available from Educational Research Information Centers.

MTC Paper 1 (August 21, 1972) D. V. Meller
Terminal Distribution and Use. (3 pp) (internal use only)

This early report gives preliminary estimates of use of CBE terminals during the development and initial evaluation of instructional materials. It was used as an aid to earliest planning for placement of terminals at military sites before direct experience was available.

MTC Paper 2 (October 26, 1972) D. V. Meller
Reviewing a PLATO Lesson. (11 pp) (internal use only)

An outline and checklist of procedures intended to increase the likelihood that valuable student test time would not be wasted in detection of errors and problems that could more economically be detected by the designer or her/his peers.

MTC Report 3 (October, 1975) Larry Francis, Merle Goldstein, & Eileen Call-Himwich
Lesson Review. (154 pp) (ED 124 132)

A guide to techniques and uses of reviews of CBE lessons, including step-by-step procedures, samples, and practice reviews. Based on techniques experimentally demonstrated to be effective in improving the usefulness of review comments by persons with instructional design experience, this report covers practical problems such as selection of reviewers, the sociology of reviewing, and potential negative outcomes of reviewing.

MTC Report 4 (July, 1974) J. P. Neal

The CGE-PLATO Electronic Laboratory Station Structure and Operation. (99 pp) (ED124145)

This report describes an application of CBE in simulations used in training for the use of particular items of equipment. Technical details of interface design and logic are presented for a training application which requires the computer to sense interconnections between elements of electronic circuitry and test equipment as well as panel settings of the electronic test equipment.

MTC Report 5 (December, 1974) J. P. Neal

Electronic Laboratory Instruction Using the CGE-PLATO Laboratory Station. (111 pp) (available from CERL only)

A brief summary of the philosophy and technique of using the Computer-Guided-Experimentation approach in instruction is presented in this report together with a review of opinions and usage of students in a course on introductory electronic laboratory techniques which used CGE-PLATO.

MTC Report 6 (December, 1974) J. P. Neal

The CGE-PLATO Electronic Laboratory Instructional Programs. (232 pp) (ED 124 146)

This report gives source code listings in the TUTOR language for 12 instructional lessons designed for use with the CGE-PLATO equipment.

MTC Report 7 (November, 1976) Larry Francis

The TUTOR Training Course: Lessons Learned. (126 pp, 7 Appendixes) (ED 135 377)

Approximately 100 new authors were taught to use the TUTOR language over a period of three years. The two- to three-week sequence developed by the MTC Group was the first formal author training program for the TUTOR language. The materials were developed in an evolutionary fashion to meet needs of new CBE authors working in military settings. The report details major problems encountered, solutions applied, and evaluation of the final form of the instruction. Findings and conclusions appropriate to the needs of instructors of new CBE authors, developers of author training materials, and managers of CBE development centers are highlighted. Included are 13 principles found effective in teaching this material, four unresolved problems encountered, examples of good and poor techniques, standards, and expected completion times for the sequence.

MTC Report 8 (January, 1977) Eileen Call-Himwich
An Assessment of Lesson Review as a Formative Evaluation Tool. (33 pp)
(ED 140 775)

Lesson reviews can potentially provide both a means of increasing lesson quality and a means of increasing the design skills of lesson authors. This report describes the evolution of the lesson review process developed by the MTC Group over a three-year period. Aspects of the process found to be crucial to effectiveness included reviewer location (on-site reviews were more effective than those done at a distance), reviewer status (reviewers with perceived authority equal to that of the designer were more effective than those with higher or lower status), review format (rapid reviews of work in progress on points mutually agreed to by both reviewer and reviewee had more impact on the final product than reviews done on completed products and based only on the reviewer's perception of needs).

MTC Report 9 (December, 1976) Larry Francis
PLATO IV Terminal Peripheral Devices. (69 pp)
(ED 135 378)

Empirical results of implementations of three major PLATO IV peripheral devices (the microfiche system, the touch panel, and the random-access audio device) are examined. In addition to listing operating characteristics of these devices, an assessment of efforts and skills required for their use and an examination of alternatives was made. Intended mainly as an aid to decision makers, the report emphasizes managerial considerations in use of these devices. It notes specific drawbacks and concludes that on-site testing and maintenance are needed for reliable performance. Although some hardware considerations are discussed, the basic approach is from a human-factors viewpoint.

MTC Report 10 (January, 1977) Joseph A. Klecka
An Overview of Chanute Lessons. (80 pp)
(ED 151 015)

A survey of current lesson development was considered essential to determine the quality and effectiveness of instructional material produced on the PLATO IV computer-assisted instruction system. The trial period lasted for several years. Both civilian and military personnel developed the lessons, in consultation with the Military Training Centers Group at the Computer-Based Education Research Laboratory, University of Illinois, for the Defense Advanced Research Projects Agency. Eight representative lessons were selected by a Chanute staff member. Then an evaluator prepared in-depth reviews of each, both in the formative and summative stages. Data gathered from the individual analyses formed the basis for the final report. It indicated general trends and isolated problem areas in the instructional design. The study resulted in an assessment of the instructional effectiveness and utilization of the pedagogical capabilities of the PLATO system in one training environment.

MTC Report 11 (March, 1977) Joseph A. Klecka
Three Aspects of PLATO Use at Chanute AFB: CBE Production Techniques, Computer-Aided Management, and Formative Development of CBE Lessons. (79 pp)
(ED 151 015)

Lesson production was studied during the process of instructional system development (ISD) at Chanute AFB. This report considers four major factors influencing lesson production: implementation of the "lean approach", the ISD role in lesson production, the transfer of programmed instruction techniques to CBE, and the general method of lesson production (group vs. individual). Each factor is discussed in terms of its effect on the quantity and quality of lesson production.

MTC Report 12 (June, 1977) Esther R. Steinberg (Editor), with R. A. Avner, Eileen Call-Himwich, Larry Francis, H. A. Himwich, Joseph A. Klecka, A. Lynn Misselt, and Esther R. Steinberg

Critical Incidents in the Evolution of PLATO Projects. (70 pp)

(ED 148 298)

This report is intended to serve as a resource for the development of management and instructional guidelines for computer-based education (CBE). Although the data in it were gathered from PLATO projects only, they represent projects which varied widely in target populations (elementary through professional students), subject matter content, type of implementation, and size and scope. Therefore, the report provides information useful both to PLATO users and to developers of CBE in general.

Critical incidents are defined in terms of four criteria, then more than 125 case histories of critical incidents are documented. These histories are organized by topics, rather than projects, so as to provide a taxonomy of matters or issues which are critical during project development. The report also includes summaries and analyses of the processes and procedures and their subsequent effects.

MTC Report 13 (August, 1977) Larry Francis

A Comparison of the Costs for Illustrations Presented by the Plasma Panel and Microfiche. (17 pp)

(ED 148 299)

The facilities of the microfiche projector and the plasma panel overlap somewhat. Each has its unique capabilities and constraints, but in many cases either can be used. Some authors and site directors consistently choose microfiche over plasma displays, or vice versa, because they are convinced one is considerably less expensive. However, to the best of our knowledge, no cost comparisons have been published. This study was undertaken to explore the costs associated with each display technique for those cases where either suffices.

MTC Report 14 (September, 1977) H. A. Himwich (Editor), with A. Lynn Misselt, H. A. Himwich, Larry Francis, R. A. Avner, Kikumi Tatsuoka, and Joseph Klecka Critique and Summary of the Chanute AFB CBE Project. (144 pp)
(ED 150 947)

This report consists of two parts: a site history and summary and a critique and expansion of an Air Force-produced evaluation of the Chanute PLATO project. The site history traces the project through a variety of management and lesson development styles. These supplement the history described briefly in the Air Force report.

The critique portion of this report analyzes the Air Force report chapter by chapter. For each section comments, elaborations, or further statistical treatments are provided. The final comment in this report agrees with a basic conclusion of the Air Force report by stating, "we suggest that readers of the AFHRL report not view the Chanute experience as an example of how training can be structured around a CBE system to take maximum advantage of its capabilities, but as an example of how PLATO can be incorporated into a traditional military training environment without causing changes in basic routines."

MTC Report 15 (September, 1977) Larry Francis and Tamar Weaver
Analysis of Student Interaction Data from CBE Lessons. (26 pp)
(ED 152 237)

Features of the PLATO IV CBE system allow the gathering of large quantities and varieties of information describing the interactions of students with CBE courseware. Until recently this type and volume of data have not been easily available, and hence few techniques or guidelines for its analysis have been investigated. This report describes some initial attempts and the current status of efforts to collect, condense, and analyze these data for the purpose of diagnosing student problems and improving instruction.

MTC Report 16 (October, 1977) H. A. Himwich

A Comparison of the TICCIT and PLATO System in a Military Setting. (26 pp) (ED 152 238)

This report describes the initial phases of a pilot test to determine the effectiveness of computer-based network systems to teach geographically dispersed students enrolled in Air Force extension courses at the Air University. The project became a comparison between the PLATO and TICCIT systems. As far as we know, this project is the only one in which the two systems were compared side-by-side, developing materials for the same objectives, and being staffed by comparably qualified people.

MTC Report 17 (October, 1977) Larry Francis

Guidelines for Establishing and Managing a Computer-Based Education Site. (140 pp) (ED 150 966)

Management guidelines are presented for three crucial phases. Part I contains a number of questions which site staff members should try to answer when establishing or while operating a computer-based education (CBE) site. Each question is followed by a brief commentary. Part II contains suggestions for selecting and training the staff of a site. In order to keep the commentary to the questions in part I brief, detailed discussions of some topics have been placed in part III of these guidelines. Part III also contains recommendations and suggestions about topics not introduced in parts I and II.

MTC Report 18 (November, 1977) Eileen Call-Himwich and Esther R. Steinberg

Myth and Reality: Essential Decisions in Computer-Based Instructional Design. (38 pp) (ED 152 239)

Most "how-to" guides start from the beginning and work forward. This one works backward. It starts with a number of common CAI author "myths" (misconceptions) and their unpleasant consequences, then works backward to discuss how the matter might better have been approached in the first place. For this reason, this guide is not so much an attempt to instruct as to forewarn.

MTC Report 19 (December, 1977) H. A. Himwich (Editor), with H. A. Himwich, Eileen Call-Himwich, R. A. Avner, and A. Lynn Misselt

Summary and Analysis of the Aberdeen CBE Project. (144 pp)

The U. S. Army Ordnance Center and School studied the acceptability of CBE instruction to students and instructors, the reliability of the PLATO CBE system, its cost and instructional effectiveness, and resources needed for preparation of effective CBE materials. The implementation was judged to be generally successful, and PLATO was found to be acceptable on all points except cost for the student population involved. Products of the instructional design approach used by this project were assessed and judged to be successful in meeting short-term instructional goals. Pilot studies compared mastery-learning materials implemented on CBE to parallel materials implemented on other individualized media. The CBE materials gave equivalent learning with significantly greater time savings than alternative individualized media.

MTC Report 20 (January, 1978) Larry Francis, Joseph A. Klecka, and A. Lynn Misselt

Selected Characteristics of Tutor Programs Produced in ARPA Sponsored PLATO Projects. (31 pp)

(ED 151 018)

The purposes of the study were:

1. To demonstrate the potential of computer-based scanning of CBE programs as a means for extracting information about the programming techniques used.
2. To suggest the use of computer-scanning techniques to aid management of CBE development efforts.
3. To provide additional information about the products of CBE lesson development projects conducted under DARPA sponsorship.

The scope of the study was limited to include only a few of the more interesting and potentially useful parameters that can be easily measured by computer-scanning techniques. The lesson characteristics selected for examination were chosen on the basis of (a) the ease and reliability of their measurements, (b) their importance in CBE, and, (c) their usefulness in illustrating the potential of this technique.

MTC Report 21 (January, 1978) A. Lynn Misselt and Eileen Call-Himwich
Analysis of Sheppard AFB Computer-Based Education Project. (100 pp)
(ED 160 107)

This report summarizes two aspects of the "Problem Oriented Medical Curriculum" developed as part of the Sheppard Air Force Base PLATO project. The first part of the report summarizes and discusses the project history. Project outcomes are analyzed and an overall summary of the project is provided.

In the second part of the report the Sheppard couseware is examined. Included are discussions of problem-orientation, lesson design, instructional approaches, and lesson development.

MTC Report 22 (January, 1978) Kikumi Tatsuoka
Approaches to Validation of Criterion-Referenced Tests and Computer-Based Instruction in a Military Project. (60 pp)
(ED 161 434)

Problems involved in setting validation criteria for mastery-learning of CBE lesson materials are examined in this report. Several models of performance scores were tested against actual data from materials developed at a DARPA CBE site. The Bayesian binomial model (beta binomial) matched data better than a sample binomial model and is recommended for setting lesson validation criterion levels where the assumptions for this model are met.

MTC Report 23 (January, 1978) Kikumi Tatsuoka (Editor), with Kikumi Tatsuoka, A. Lynn Misselt, Joseph Klecka, and Patrick Maritz
Attitude and Performance of Military Students and Instructor Attitude in Computer-Based Technical Training. (61 pp)

Attitudes of students and instructors were measured by several instruments. Factor analytic and multiple regression techniques were employed in assessing student attitude and performance measures. It was found that mechanical and system failures had no significant effect on student performance but did have a negative effect on their attitude toward use of CBE. Students using CBE materials showed stable, reliable positive attitudes toward the program while those not using CBE showed attitudes which varied with the popularity of their instructors.

Instructor attitudes were generally positive toward the CBE program and materials but showed negative effects after experiencing failures of CBE system service. Student attitudes toward the CBE program were seen as being affected by instructor attitudes.

MTC Report 24 (September, 1980) Allen Avner

Measuring and Reporting CBE System Reliability. (35 pp)

Measures of computer system reliability commonly used for batch and interactive computer applications are not necessarily appropriate to the needs of CBE systems. This report reviews the major factors involved in determining the effect of unreliability on system availability for CBE. Results of an empirical study of the relationship between various indexes of overall system availability and user attitudes are described. One index (time-weighted-problems-per-unit-time) was found to be highly correlated with user attitude and to have properties (such as additivity) which make it very convenient for measuring contributions of component unreliability to total system reliability.

APPENDIX II

OTHER PUBLICATIONS PRODUCED

In addition to being described in the formal reports produced as a part of the contract, portions of the studies appeared as articles in professional journals and as chapters of technical books.

Avner, R. A. Courseware Transport--When and How? ADCIS Proceedings, Winter 1977, 162-163.

Avner, R. A. Internal Evaluation of the PLATO System. ADCIS Proceedings, Winter 1977, 197-199.

Avner, R. A. Cost-Effective Applications of CBE. Educational Technology, 1978, 18(4), 24-26.

Avner, R. A. Production of Computer-based Instructional Materials. In O'Neil, H.F., Jr. (Ed.), Issues in Instructional Systems Development. New York: Academic Press, 1979.

Francis, L. Factors Contributing to Success in Author Training. ADCIS Proceedings, Winter 1977, 192-196.

Hody, G. L. & Avner, R. A. The PLATO System: An Evaluative Overview. In De Land, E.C. (Ed.) Information Technology in Health Science Education. New York; Plenum Press, 1978.

Steinberg, E. R. Learner Control and CAI: Assumptions, Findings, and Questions. ADCIS Proceedings, Winter 1977, 292-297.

Steinberg, E. R. Review of student control in computer-assisted instruction. Journal of Computer-Based Instruction, February 1977, Vol. 3, No. 3, 84-90.

Steinberg, E. R. Critical decisions: An evaluation of an evaluation. ADCIS Proceedings, 1978, 420-428.